

Day-of-week pattern of PM10 in the South Coast, 1987-1998

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As part of our ongoing analysis of the “weekend effect”, we examined the pattern of particulate matter 10 microns in diameter or less (PM10) through the week in the South Coast Air Basin. For 1987 through 1998, 23 sites in the SSI (size selective inlet) monitoring network showed data. Among these, 11 sites had all 12 years of PM10 data. This document presents our analysis of PM data in the South Coast. At the end of our discussion, we outline possible areas for further investigation. In the future, we plan to parallel the analysis in other regions, including the San Francisco Bay Area and the Sacramento Valley.

PM10 concentrations are measured on a 1-in-6-day schedule. As such, the observations for a site can be considered independent because the meteorology is such that stagnation events usually last less than 6 days. Thus, we’ve performed an analysis of variance to optimally estimate the day-of-week geometric means and test for statistical significance of the differences between the means (treating the day of week as fixed effect and the year as random). All tables and figures follow the text discussion.

Day-of-week PM10 means

Table 1 displays the estimated PM10 geometric means by day of the week for each site in the South Coast. Table 2 summarizes the count of the observations by year for each site. Generally speaking, about 60 observations are observed on each year at each site, equating to approximately 7 or 8 observations for each day of the week.

Figures 1 through 4 display the results for Azusa, Los Angeles, North Long Beach, and Riverside-Rubidoux. Clearly, PM10 is relatively low during the weekend as compared to weekdays. The prevalent pattern for PM10 is to be somewhat constant on Monday and Tuesday, then decrease slightly on Wednesday, increase back on Thursday and Friday, followed by decreases on Saturday and Sunday. While PM10 seems to be lowest on Sundays among all days and, relative to weekdays, it seems to decrease on Wednesday, we need to assess the statistical significance of the differences between day-of-week means. This is the topic of discussion in the next section.

Differences between day-of-week means

We tested for differences between day-of-week means, using significance level of 5% for each pair of days. Among the 23 sites, 4 had no significant differences between any day of the week. At 6 sites, Sunday PM10 is significantly lower than Monday, Tuesday, Thursday, and Friday. However, it is not significantly different from Saturday, and Wednesday PM10 is not different from Tuesday. In fact, we see Wednesday PM10 significantly lower than Friday at 8 sites, and it is lower than Thursday at 6 sites. This “lower Wednesday” PM10 phenomenon is noteworthy; it is most apparent at Lake Gregory, where Sunday PM10 is not significantly lower than other days. Redlands stands out as being the single site where Thursday PM10 is significantly different from Sunday, Monday, Tuesday and Wednesday.

Saturday PM10 is significantly lower than Friday at 5 sites. At Azusa, it significantly differs from Monday, Tuesday, and Thursday also.

While there are no clear spatial patterns to the above observations, we see that for most sites, Sunday and Wednesday PM10 are significantly lower than at least one other day of the week.

Table 3 indicates whether the differences in mean PM10 concentrations are significant at 5% level for each pair of days. A significant difference is indicated by a “Y” for “Yes”; otherwise, it is blank. For example, at Anaheim, Sunday PM10 is significantly different from Tuesday and Thursday, Friday PM10 differs Sunday, Monday, Wednesday and Saturday. Sites without any significant differences (Avalon, Banning-S. Hathaway St., Newport Beach, San Bernardino, Riverside-Rubidoux) are not listed in this table.

Limitations of results

The results of this study are based on PM10 data collected on a 1-in-6-day schedule across all months during 1987-1998, without consideration of seasonality and trends. At some sites, the data are very limited. As expected, some of the differences between day-of-week means become insignificant at a lower (for example, 1 or 2%) significance level. Thus one should use caution when interpreting the results.

Possible areas for future study

- Similar analysis on PM10 data for other regions of California.
- PM TEOM.
- PM species (dichotomous fine and coarse fractions, nitrates, sulfates, ammonium and chloride).
- PTEP (PM10 Technology Enhancement Program) data from SCAQMD.
- Dividing time periods into blocks of 3 or 5 years each.
- Separating data into seasons.

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Table 1

Estimated PM10 geometric means (in ug/m³) by day of week

SITE NAME	Sunday	Monday	Tuesday	Weds.	Thursday	Friday	Saturday
Anaheim-Harbor Blvd	31.77	34.29	37.36	33.84	39.14	41.53	33.83
Avalon-Crescent Avenue	24.61	26.65	20.90	22.99	16.49	19.31	29.11
Azusa	37.31	47.37	48.93	43.15	49.39	49.25	39.65
Banning-Allesandro	26.01	31.03	30.78	28.26	31.93	31.05	27.83
Banning-South Hathaway Street	16.97	13.08	20.62	36.92	36.00	10.95	14.28
Burbank-W Palm Avenue	38.70	43.68	44.15	41.51	46.99	47.98	42.25
El Toro	28.73	33.94	34.00	30.47	33.81	36.35	32.46
Fontana-Arrow Highway	47.19	57.36	59.52	51.10	56.59	56.28	49.09
Hawthorne	29.21	33.99	35.21	31.62	38.40	34.80	32.66
Lake Gregory	24.96	24.10	25.32	20.50	27.55	27.26	27.00
Los Alamitos-Orangewood Ave	40.40	51.65	50.14	43.41	32.69	39.07	38.61
Los Angeles-North Main Street	38.43	44.57	46.45	42.32	45.89	48.96	42.08
Newport Beach-University	25.88	29.85	25.94	29.01	28.79	31.83	29.62
Norco-Norconian	40.00	40.25	46.59	39.39	49.65	46.60	39.99
North Long Beach	33.41	37.61	40.09	35.64	38.85	40.37	36.21
Ontario-Airport	47.06	55.73	56.49	50.42	55.32	60.59	49.01
Perris	36.85	41.30	45.46	38.72	41.82	45.30	37.15
Redlands-Dearborn	32.93	33.47	34.02	34.78	45.55	36.81	38.19
Riverside-Rubidoux	57.58	61.82	64.23	56.81	61.09	63.60	60.14
San Bernardino-4th Street	48.65	51.15	51.66	49.34	53.93	54.69	47.52
Santa Clarita-County Fire Station	30.35	33.32	33.07	33.25	37.50	36.42	31.07
Santa Clarita-Honby	33.70	39.07	26.83	25.29	50.67	50.68	32.28
Temecula-Rancho California Road	21.89	23.31	26.03	24.93	30.18	30.87	25.36

Table 2

Count of PM10 observations by year for each site in the South Coast

Site Name	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Anaheim-Harbor Blvd				59	59	56	61	61	60	60	60	61
Avalon-Crescent Avenue				19								
Azusa	59	61	59	60	57	61	59	62	60	58	60	57
Banning-Allesandro	61	57	60	54	57	46	57	60	61	52	57	55
Banning-South Hathaway Street												16
Burbank-W Palm Avenue	59	59	58	60	60	58	58	60	59	59	56	59
El Toro	60	61	60	55	57	60	61	59	60	61	56	54
Fontana-Arrow Highway	60	60	61	59	54	53	60	60	61	61	61	60
Hawthorne			55	60	60	54	61	61	58	60	55	59
Lake Gregory			53	59	48	26	50	59	59	60	58	58
Los Alamitos-Orangewood Avenue	56	57	55									
Los Angeles-North Main Street	57	58	58	60	57	61	61	60	60	60	60	60
Newport Beach-University					29	60	1					
Norco-Norconian							61	60	60	58	60	57
North Long Beach	53	60	59	58	39	57	61	60	59	48	57	59
Ontario-Airport	60	60	61	59	58	59	60	61	62	63	59	59
Perris	15	55	59	61	60	58	60	61	60	61	60	53
Redlands-Dearborn							54	59	59	60	60	60
Riverside-Rubidoux	60	61	61	61	60	62	61	61	61	63	59	78
San Bernardino-4th Street	61	56	59	60	60	60	59	61	60	60	60	58
Santa Clarita-County Fire Station			39	57	57	60	55	58	61	53	59	55
Santa Clarita-Honby			41	5								
Temecula-Rancho California Road					29	57	61	15				

Table 3

Significant differences between day-of-week PM10 geometric means
(Y indicates a significant difference at 5% level)

Anaheim		Sun	Mon	Tues	Weds	Thurs	Fri	Sat
	Sun			Y		Y	Y	
	Mon						Y	
	Tues	Y						
	Weds						Y	
	Thurs	Y						
	Fri	Y	Y		Y			Y
	Sat						Y	
Azusa		Sun	Mon	Tues	Weds	Thurs	Fri	Sat
	Sun		Y	Y		Y	Y	
	Mon	Y						Y
	Tues	Y						Y
	Weds							
	Thurs	Y						Y
	Fri	Y						Y
	Sat		Y	Y		Y	Y	
Banning-Allesandro		Sun	Mon	Tues	Weds	Thurs	Fri	Sat
	Sun					Y		
	Mon							
	Tues							
	Weds							
	Thurs	Y						
	Fri							
	Sat							
Burbank-W Palm Ave		Sun	Mon	Tues	Weds	Thurs	Fri	Sat
	Sun					Y	Y	
	Mon							
	Tues							
	Weds						Y	
	Thurs	Y						
	Fri	Y			Y			
	Sat							
El Toro		Sun	Mon	Tues	Weds	Thurs	Fri	Sat
	Sun		Y	Y		Y	Y	
	Mon	Y						
	Tues	Y						
	Weds						Y	
	Thurs	Y						
	Fri	Y			Y			
	Sat							

Fontana-Arrow Hwy	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun		Y	Y		Y	Y	
Mon	Y						
Tues	Y						Y
Weds							
Thurs	Y						
Fri	Y						
Sat			Y				
Hawthorne	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun		Y	Y		Y	Y	
Mon	Y						
Tues	Y						
Weds					Y		
Thurs	Y			Y			Y
Fri	Y						
Sat					Y		
Lake Gregory	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun							
Mon							
Tues				Y			
Weds			Y		Y	Y	Y
Thurs				Y			
Fri				Y			
Sat				Y			
Los Alamitos	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun							
Mon					Y		Y
Tues					Y		
Weds					Y		
Thurs		Y	Y	Y			
Fri							
Sat		Y					
Los Angeles-N. Main	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun		Y	Y		Y	Y	
Mon	Y						
Tues	Y						
Weds						Y	
Thurs	Y						
Fri	Y			Y			Y
Sat						Y	

Norco-Norconian	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun							
Mon							
Tues							
Weds					Y		
Thurs				Y			
Fri							
Sat							
North Long Beach	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun			Y		Y	Y	
Mon							
Tues	Y						
Weds						Y	
Thurs	Y						
Fri	Y			Y			
Sat							
Ontario-Airport	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun		Y	Y		Y	Y	
Mon	Y						
Tues	Y						
Weds						Y	
Thurs	Y						
Fri	Y			Y			Y
Sat						Y	
Perris	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun			Y			Y	
Mon							
Tues	Y						Y
Weds							
Thurs							
Fri	Y						Y
Sat			Y			Y	
Redlands-Dearborn	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun					Y		
Mon					Y		
Tues					Y		
Weds					Y		
Thurs	Y	Y	Y	Y			
Fri							
Sat							

Santa Clarita - County Fire Station	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun					Y	Y	
Mon							
Tues							
Weds							
Thurs	Y						Y
Fri	Y						
Sat					Y		
Santa Clarita - Honby	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun							
Mon							
Tues					Y	Y	
Weds					Y	Y	
Thurs			Y	Y			
Fri			Y	Y			
Sat							
Temecula	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Sun					Y	Y	
Mon							
Tues							
Weds							
Thurs	Y						
Fri	Y						
Sat							

Figure 1

PM10 SSI, 1987-1998, Azusa

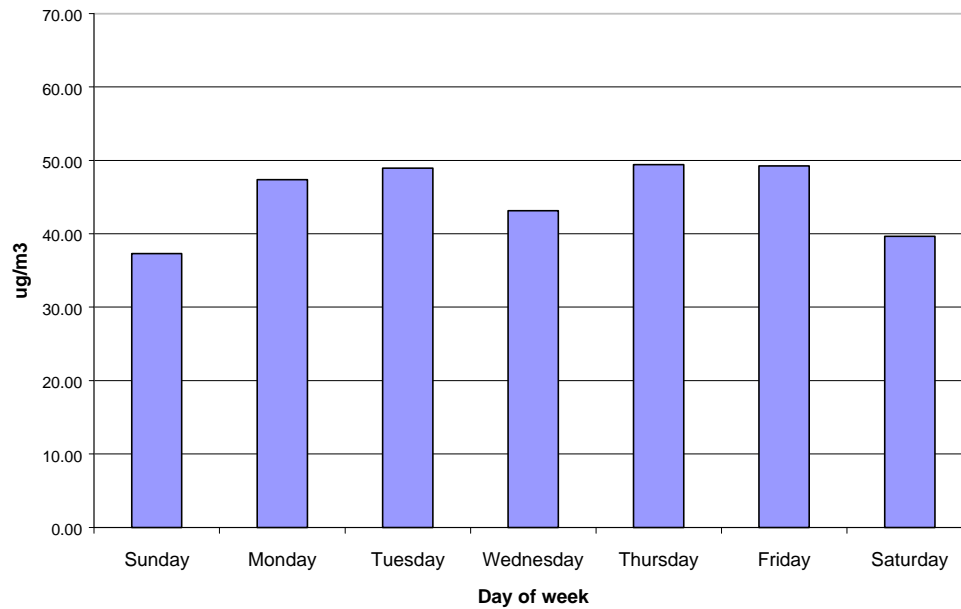


Figure 2

PM10 SSI, 1987-1998, Los Angeles

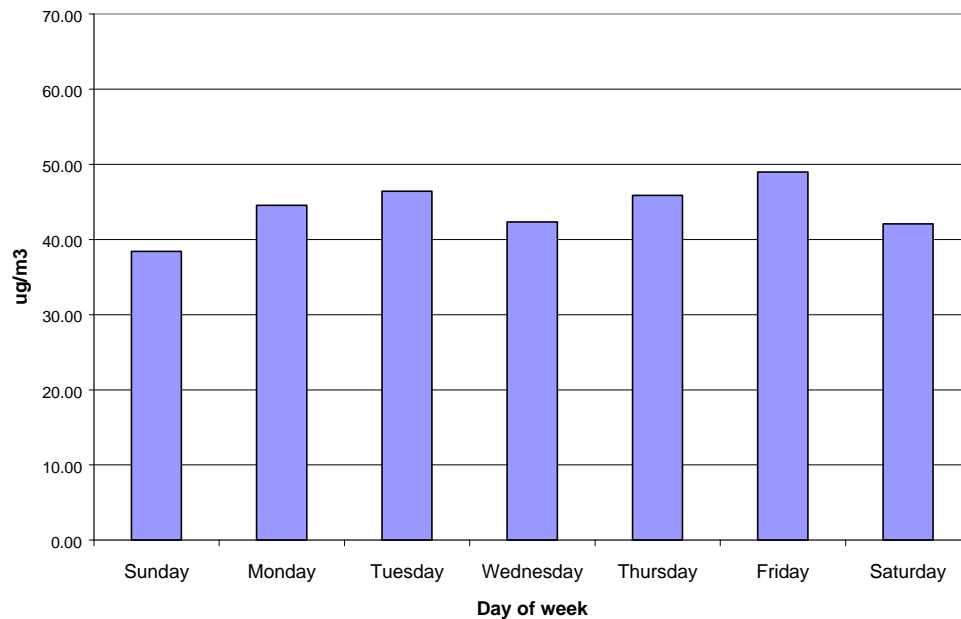


Figure 3

PM10 SSI, 1987-1998, North Long Beach

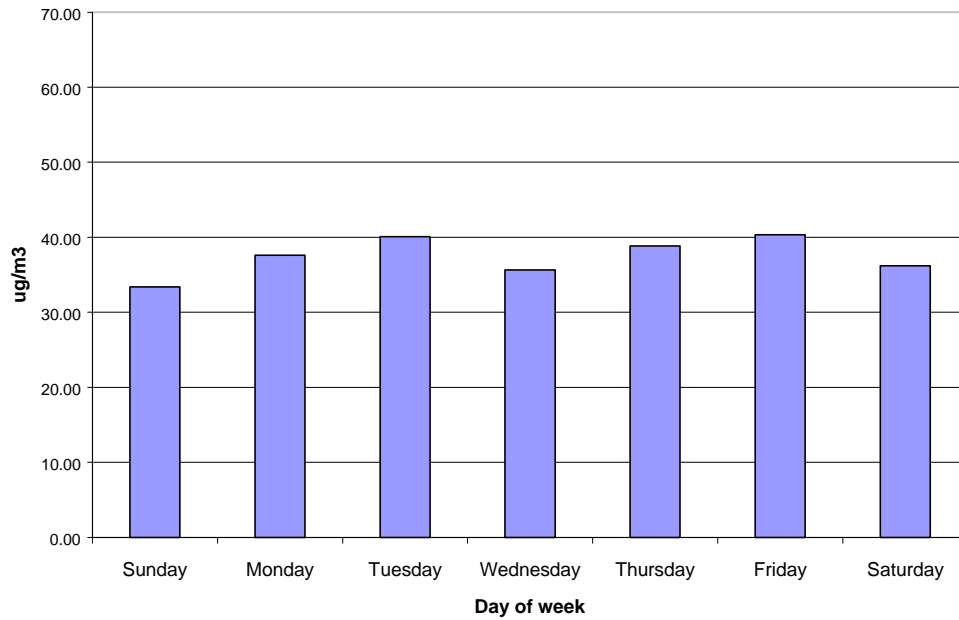


Figure 4

PM10 SSI, 1987-1998, Riverside-Rubidoux

